

1 Claim 1. An improved disk centrifuge capable of measuring scattered light at a plurality  
2 of angles from a sample undergoing separation therein comprising

3 a) a cylindrically symmetric chamber impressed to rotate about an axis of rotation  
4 through its generator, said chamber incorporating a cylindrical fluid-bearing  
5 cavity means within circular wall means of said chamber, said cavity extending  
6 over a range of radial distances from said axis of rotation, and said walls  
7 incorporating region transparent to light over a range of radial distances;

8 b) sample introduction means whereby said sample may be introduced into said  
9 cylindrical fluid-bearing cavity between said circular wall means, so that said  
10 sample undergoes separation by resultant centrifugal forces as said cylindrical  
11 chamber undergoes impressed rotation about said axis of rotation;

12 c) a flat transparent cylindrically symmetric optical region of one of said wall  
13 means;

14 d) a stationary external light source means providing a fine beam of light passing  
15 successively through said transparent region and said sample undergoing  
16 separation;

17 e) a stationary forward transmitted light beam trapping means into which said fine  
18 beam of light enters after leaving said transparent region;

19 f) a plurality of stationary detector means arranged about said light beam at varying  
20 angles therefrom, each said detector means masked by collimating means to  
21 accept only light scattered by said sample means from region of said sample  
22 illuminated by said incident light beam and passing through said transparent  
23 region; and

1       g) electronic means to convert signals from said scattered light detectors  
2       successively in time, converting said signals into digital representations, and  
3       transmitting said resultant digital signals to computer means for subsequent  
4       processing and analysis.

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6   **Claim 2.** An improved disk centrifuge capable of measuring scattered light at a plurality  
7   of angles from a sample undergoing separation therein comprising

8       a) a cylindrical structure impressed to rotate about an axis of rotation through its  
9       generator, said cylindrical structure containing cavity means to incorporate  
10      transparent cuvettes, said cuvettes

11               i. containing samples, each said sample undergoing separation by  
12               resultant centrifugal forces as said cylindrical structure undergoes  
13               impressed rotation about said axis of rotation;

14               ii. having a plane transparent optical surface through which an  
15               incident light beam may pass and an opposite plane transparent  
16               optical surface to provide a structure with said sample between  
17               said two surfaces; and

18               iii. oriented radially so that said resultant centrifugal force separates  
19               particles in a radial direction.

20       b) a stationary external light source means providing said fine beam of light passing  
21       successively through transparent regions of said optical surfaces of said sample  
22       containing cuvette;

- 1 c) a stationary forward transmitted light beam trapping means into which said fine  
2 beam of light enters after leaving normally from said transparent cuvette;
- 3 d) a plurality of stationary detector means arranged about said light beam at varying  
4 angles therefrom, each said detector means masked by collimating means to  
5 accept only light scattered by said sample means from region of said sample-  
6 containing cuvette illuminated by said incident light beam and passing through  
7 said optical surface means; and
- 8 e) electronic means to convert signals from said scattered light detectors  
9 successively in time, converting said signals into digital representations, and  
10 transmitting said resultant digital signals to computer means for subsequent  
11 processing and analysis.

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13 Claim 3. An improved analytical ultracentrifuge capable of measuring scattered light at a  
14 plurality of angles from a sample undergoing separation therein comprising

- 15 a) a cylindrical structure impressed to rotate about an axis of rotation through its  
16 generator, said cylindrical structure containing cavity means to incorporate  
17 transparent cuvettes, said cuvettes
- 18 i. containing samples, each said sample undergoing  
19 separation by resultant centrifugal forces as said cylindrical structure  
20 undergoes impressed rotation about said axis of rotation;
- 21 ii. having a plane transparent optical surface through which an  
22 incident light beam may pass and an opposite plane transparent

1                    optical surface to provide a structure with said sample contained  
2                    between said two surfaces; and  
3                    iii.            oriented radially so that said resultant centrifugal force  
4                    separates particles in a radial direction.

5            b) a first light source means directed normal to said rotating cylindrical structure  
6            providing said fine beam of light passing successively through transparent regions  
7            of said optical surfaces of said sample containing cuvette;

8            c) a forward transmitted light beam trapping means into which said fine beam of  
9            light enters after leaving normally from said transparent cuvette;

10          d) a plurality of light scattering detector means arranged about said light beam at  
11          varying angles therefrom, each said light scattering detector means masked by  
12          collimating means to accept only light scattered by said sample means from  
13          region of said sample-containing cuvette illuminated by said incident light beam  
14          and passing through said plane optical surface means;

15          e) a second light source at the same radial distance from said axis of rotation as said  
16          first light source providing a second beam of light directed normal to said rotating  
17          cylindrical structure and passing through said cuvette when said cuvette has  
18          moved to a second angular position;

19          f) a second forward transmitted light beam trapping means into which said second  
20          fine beam of light enters after leaving normally from said transparent cuvette

21          g) a second plurality of light scattering detector means arranged about said second  
22          light beam at varying angles therefrom, each said light scattering detector means  
23          masked by collimating means to accept only light scattered by said sample means

1 from region of said sample-containing cuvette illuminated by said incident light  
2 beam and passing through said plane optical surface means;  
3 h) a mechanical support means by which said two light beam sources, said two  
4 pluralities of light scattering detector means are fixed in space relative to said  
5 rotating cylindrical structure rotating therebetween, said mechanical structure  
6 permitting its movement in radial position only;  
7 i) electronic means to convert signals from said two pluralities of scattered light  
8 detectors successively in time, converting said signals into digital representations,  
9 and transmitting said resultant digital signals to computer means for subsequent  
10 processing and analysis.

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12 Claim 4. The improved analytical ultracentrifuge of Claim 3 where each said forward  
13 transmitted light beam trapping means includes detection means to monitor intensity of  
14 said incident transmitted beam

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16 Claim 5. The improved analytical ultracentrifuge of Claim 3 where said first light source  
17 produces a light beam at a wavelength permitting measurement of said sample absorption  
18 by said detector monitoring means of said light beam transmitted through said sample  
19 means of Claim 4.

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21 Claim 6. The improved analytical ultracentrifuge of Claim 3 where said second light  
22 source is a laser.

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1 Claim 7. The improved analytical ultracentrifuge of Claim 6 where said laser source is  
2 plane polarized in a plane parallel to the radius of said rotating structure holding said  
3 sample cuvettes.

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5 Claim 8. The improved analytical ultracentrifuge of Claim 3 wherein said cuvette optical  
6 surface through which said fine light beam passes after its passage through said sample is  
7 plane along that region of said cuvette to include a selected range of radial positions  
8 along said rotating structure that said fine light beam may travel.

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11 Claim 9. The cuvette of Claim 8 wherein all optical surfaces through which the incident  
12 beam and scattered light pass are coated with transparent optical materials to reduce  
13 scattering and reflections at all air interfaces.

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15 Claim 10. The improved analytical ultracentrifuge of Claim 3 where said plurality of light  
16 scattering detector means arranged about said light beam at varying angles therefrom lie  
17 in a plane perpendicular to said beam.

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19 Claim 11. The improved disk centrifuge of Claim 2 where said forward transmitted light  
20 beam trapping means includes detection means to monitor intensity of said incident  
21 transmitted beam.

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1    **Claim 12.** The improved disk centrifuge of Claim 3 wherein said cuvette optical surface  
2    through which said fine light beam passes after its passage through said sample is plane  
3    along the length of said cuvette to include a selected range of radial positions.

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6    **Claim 13.** The cuvette of Claim 12 wherein all optical surfaces through which the  
7    incident beam and scattered light pass are coated with transparent optical materials to  
8    reduce scattering and reflections at all air interfaces.

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10    **Claim 14.** The improved disk centrifuge of Claim 2 where said plurality of light  
11    scattering detector means arranged about said light beam at varying angles therefrom lie  
12    in a plane perpendicular to said beam.

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14    **Claim 15.** The improved disk centrifuge of Claim 1 where said forward transmitted light  
15    beam trapping means includes detection means to monitor intensity of said incident  
16    transmitted beam.

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19    **Claim 16.** The improved disk centrifuge of Claim 1 wherein all optical surfaces through  
20    which the incident beam and scattered light pass are coated with transparent optical  
21    materials to reduce scattering and reflections at all air interfaces.

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1 Claim 17. The improved disk centrifuge of Claim 1 where said plurality of light  
2 scattering detector means arranged about said light beam at varying angles therefrom lie  
3 in a plane perpendicular to said beam.

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5 Claim 18. A method for measuring the molecular mass of molecules being separated in  
6 an improved analytical ultracentrifuge means incorporating two light sources comprising  
7 the steps of

- 8 a) deriving the concentration of said sample at the instant and radial location at  
9 which said sample is illuminated by the conventional light beam of said  
10 analytical ultracentrifuge by measuring the attenuation of said beam by said  
11 sample;
- 12 b) measuring the light scattered by said same sample at the instant and radial  
13 location at which said sample is illuminated by a second light beam, said  
14 scattered light detected over a range of scattering angles by means of a set of  
15 scattered light detectors placed in fixed proximity to rotating cylindrical  
16 structure of said ultracentrifuge;
- 17 c) combining said concentration and scattered light data to derive said molecular  
18 mass.

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20 Claim 19. The method of Claim 18 where said conventional light beam source and said  
21 second light beam source produce light beams that are co-linear.

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1     **Claim 20.** The method of Claim 18 where said conventional light beam source and said  
2     second light beam source produce light beams that are at identical radial distances from  
3     the axis of rotation of said improved analytical ultracentrifuge, but at different angular  
4     positions.

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6     **Claim 21.** The method of Claim 18 where said conventional light beam source produces  
7     UV light and said second light beam source produces light of a different wavelength.

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9     **Claim 22.** The method of Claim 18 where said second light beam source is a laser.